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ABSTRACT

A study examined the consistency of consonant use in the infant's transition period from babbling to early words. Phonetic data were collected from the speech of 10 infants aged 9 to 15 months. Analysis of consonant distribution patterns indicate striking segmental preferences in all 10 children, with some segments more prominent for the sample as a whole and the rest in extreme use in one or more subjects. Subjects' vocal motor schemes, or patterns of intentional use, were determined by examining the frequency and longevity of segment use, controlling for individual variations in volubility. All subjects developed early and continuing preferential use of one or more segments, and some developed a syllabic structure of one or more units. These vocal motor schemes represent competence in controlling articulation to produce forms based on a given segment, which may later be enriched and invested with meaning. (MSE)

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Vocal Motor Schemes

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At the early transition to speech, children's vocalizations show certain phonetic tendencies, such as frequent use of stops and nasals and scant use of liquids or clusters (Locke, 1983; Oller, Wieman, Doyle & Ross, 1976). Despite intensive study of this transition, the order of emergence of phonemic contrasts in words proposed by Jakobson (1941/1968) has been difficult to evaluate (Kiparsky & Menn, 1977). Rather than a discontinuity between babbling and early words, as Jakobson assumed, word and non-word vocal productions co-occur and have the same phonetic properties (Vihman, Macken, Miller, Simmons & Miller, 1985). There is no evidence for a universal order of consonant acquisition during this period. Nor is it clear how competence in intentional production could be evaluated in non-word vocalizations, where the child is not attempting an identifiable target.

The present study was designed to examine the extent to which consistency in consonant use characterizes the transition period. The results indicate that rather than a universal sequence of acquisition of consonants in words, there may be a universal tendency to establish a limited range of intentional vocal patterns prior to word use, with strong individual differences in the segmental basis of these patterns. Children's use of what seemed to be their "favorite sounds" (Ferguson, 1979) suggested that these were the basis for action schemes as described by Piaget (1962). They are motor acts which are performed intentionally and are capable of variation and combination to form larger units. The present paper documents the establishment of these vocal motor schemes and examines their influence on the form and rate of word acquisition.

Method

Data were collected at Rutgers and at Stanford from 5 boys and 5 girls each, aged 9 to 16 months. The Rutgers children were videotaped monthly in the home during free-play mother-child interactions with a standard set of toys. For the Stanford sample, audio and video recordings were made weekly in the home

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(Vihman et al., 1986). These data are being further analyzed by the methods described here to provide a replication of the present study. Phonetic transcriptions were made of the monthly Rutgers data. Reliability across the two transcribers was checked on the basis of five partial re-transcriptions, covering the age-range 10-15 months (218 vocalizations). Agreement as to length in syllables and place and manner of supraglottal consonants averaged .743 (1,011 data points). We counted the occurrences of consonants in syllable-initial position and the number of vocalizations lacking a syllable-initial consonant. Consonants occurring more than once in a vocalization were counted only once. Voicing in stops was not distinguished (e.g., [p] and [b] were treated as the same consonant).

Results

The proportional distribution of consonants revealed striking segmental preferences in all 10 children. Individual proportions and means are shown in Table 1. The most prominent segments for the sample as a whole, [h] and [t/d], served as vocal motor schemes for a majority of the children. Each of the other segments in Table 1 showed extreme use, in comparison to the sample mean, for one or more subjects. This narrow range of frequently used segments reflects the phonetic properties previously observed by Oller et al. (1976) and Vihman, Ferguson & Elbert (1986), while variation by child, even within this narrow range, suggests strong individual differences.

We next determined which segments were used with sufficient frequency and longevity to indicate competence in intentional production. Vocal motor schemes were identified by inclusion of a consistent segment in 10% (and 10 or more) of the child's vocalizations for each of three sessions, either contiguous or separated by no more than one session. This definition controls for variation in volubility (range 9-260 vocalizations in per session). The vocal motor schemes used by the children and the number of months each was used appear in Table 1.

Vocal Motor Schemes and Word Forms

If vocal motor schemes, like the action schemes described by Piaget, are capable of variation and combination in the service of goal-directed activities, such variation and combination should be exhibited in the children's phonological approaches to shaping an initial lexicon. Profiles of two of our most voluble subjects, Aislinn (Rutgers) and Molly (Stanford), illustrate the different kinds of relations found

between vocal motor schemes and the form of early word productions.

Aislinn was the only Rutgers child with a preference for [j] (yod), as shown in Table 1. Longitudinal examination of her consonant use indicated that early use of yod was the first manifestation of a range of production skills united by a focus on palatal (or high-front-vowel-like) articulation. These palatal patterns constituted a series of vocal motor schemes in non-words and apparently exercised strong influence on both production and selection of words. Looking at Aislinn's word tokens at 14 months, for example, we find several manifestations of a palatal pattern:
- use of yod: lady -> [jeiji]
- use of palatal consonants: mommy -> [ma:ɲi]
- use of Vi : eye, hi, bye.
- use of (CV)Ci: bunny -> [baeŋ:i].

Noting that these word patterns might be related to the unusual prevalence of yod in Aislinn's babble at 9 and 10 months, we traced these palatal sub-patterns longitudinally in babble as well as words.

On average, Aislinn's palatal pattern affected over one-third of her vocalizations (Figure 1). When word use became well-established, after 13 months, palatal articulation characterized an overwhelming majority of her word tokens (75%-85%). Furthermore, a more detailed look at the formation of the palatal pattern in non-word vocalizations showed that, beginning with high use of [j] at 9 and 10 months (17/30; 57%), Aislinn gradually built up more complex i/j-based patterns such that at 11 months the Vi pattern began to be used most (15/31; 48%) and from 14 months on the CVCi pattern was dominant, accounting for 35%-55% of the non-word palatal articulations.

It should be noted that some words showed phonological regression, in comparison with the adult model, as they were integrated into Aislinn's preferred pattern. For example, mommy changed from [man:ə] (10 mos.) and [mɔ̃ə] ~ [ɛ̃ mãmamə] (12 mos.) to [maji] (15 mos.) and [ma:ɲi] (16 mos.). At the same time, new words were typically shaped into palatal patterns - e.g., ball [pɔ̃i], whoo [hui] (12 mos.), blanket [baeŋ:i] (14 mos.), elephant [aijʌ̃] (15 mos.), [ai·njə] 16 mos.

By way of contrast, Molly used similar palatal articulations, but vocal motor schemes integrating them into a pattern were not apparent in her data. There is a gradual increase in i-like articulations, but words do not lead the trend and the overall frequency is far lower (Figure 1).

For Molly, the analysis of phonetic tendencies presented in Vihman et al. (1986) showed a concentration on final consonants which became a framework for vocal motor schemes. Molly made 23% use of final consonants at the point when she began using over 15 words per session (age 12-13 months), as compared to a mean use of final consonants, at that lexical level, of 10% across 7 subjects. Longitudinal analysis of Molly's word patterns revealed a focus on final consonants as early as 10 months, when cracker was produced with variants [wækˁ] ~ [kækˁ] ~ [kʌkˁ] alongside vowel-final disyllabic variants such as [pækwa]. At 12 months over half of Molly's word tokens (22/41) made use of final consonants: e.g.,

baby -> [pe:p]
good girl -> [kukʌk]
oops -> [ɛp]

When Molly's lexical output increased sharply at 13 months she began to use a new pattern for final stops and nasals. The pattern involved emphasis of the final consonant - extra long aspiration for a stop, lengthening for a nasal - and the addition of a final vowel, either [i] or [z]. E.g.:

clock -> [kak:ʰI]
bang -> [bæŋ:i] ~ [bæini]

In later sessions Molly continued to increase her use of final consonants, drawing words with nasals (green, Graham, Nicky) into her nasal pattern ([kɐn:i], [kɔn:i] and [ɛn:i], respectively) but also adding other stop-final words (red, stuck), and producing [t] for final voiceless fricatives (bus, house, cheese, Ruth).

Figure 2 shows Molly's dramatic increase in use of final consonants in words over time, up to a remarkable 47% at 16 months. In contrast, Aislinn shows a consistently low level of use, though there is a slight increase in words at 16 months, to 11%. The fact that both girls show higher use in words no doubt reflects the fact that English is a language particularly rich in final consonants.

The difference in word selection is striking. Aislinn made heavy use of diminutives (Ernie, Bonnie) and baby-talk words ending in -y (bunny, daddy, dolly), which exhibit a palatal pattern. We can speculate that these relatively high frequency English words attracted Aislinn because of her favorable predisposition toward palatal patterns, and that it was the interactive match between child scheme and adult phonological structure which produced Aislinn's extremely high frequency pattern at 14-15 months. In contrast, Molly used few palatal pattern adult words, focussing instead on words with final consonants.

Specifically, in Molly's first month of high lexical use, she targetted 9 obstruent-final words out of 15 non-onomatopoeic words, while at a comparable lexical point Aislinn targetted only 4 obstruent-final words out of 21 different non-onomatopoeic words.

Vocal Motor Schemes and Lexical Progress

Although the definition of vocal motor scheme makes no reference to a meaningful or communicative use of these patterns, the examples from Aislinn and Molly show how the capability for intentional production of a sound pattern can be used by a child in the acquisition of words. Equally interesting was the fact that the two Rutgers subjects who did not develop a supraglottal vocal motor scheme by 16 months were low in word production over the course of the study. We therefore investigated the relationship between the children's use of vocal motor schemes and their development of a referential lexicon.

To obtain vocal motor scheme scores we summed across months and corrected the raw total to account for variation in number of observation sessions (Table 1). Aislinn, for example demonstrated vocal motor schemes for [p/b], [t/d], [j], and [h] for a pooled sum of 22 months. Division by number of observation sessions (8) yielded a corrected vocal motor scheme score of 2.75.

The referential lexicon was defined as the total number of strong nominal and relational word types used by the child in the course of the study. Strong nominals are words used with reference to several different entities which would constitute exemplars of some adult concept (e.g., dog referring to a picture and to a neighbor's dog). Relational words refer to reversible spatial or temporal events (e.g., allgone when a cookie has been eaten, no when a puzzle piece won't fit.) Occurrences in different contexts are required (McCune-Nicolich, 1981), indicating a basis of meaning beyond the routine. (See Table 1).

Vocal motor scheme use and referential lexical development were significantly related (Spearman Rank Correlation .78, $p < .01$), as were volubility and referential lexicon (.67, $p < .05$), while volubility and vocal motor scheme use were not (.49, N.S.). Although higher volubility should make vocal motor scheme identification more likely, volubility is insufficient to account for the relationship with lexical development. In fact, the pattern of correlations obtained suggests that the the child's active construction of intentional patterns (vocal motor schemes) contributes to lexical development in a

way which goes beyond simple high frequency vocalization (volubility).

Discussion

The children in this study all developed an early and continuing preferential use of one or more segments. Unlike the more general tendencies described by Locke (1983) these individual preferences formed the basis for vocal motor schemes. For some children these developed a syllabic structure, of one or more units. Although the present paper investigated consonant-based schemes, in principle vowel shapes and prosodic patterns might also be exploited in the formation of vocal motor schemes.

The earliest vocal motor schemes have no apparent meaning for the child as words later will. Rather, it seems that the children have achieved competence in controlling articulation to produce forms based on a given segment. In the case of vocal motor schemes based on supraglottal articulation, the children have considerable scope for playful variation and combination of a range of interrelated motor acts. Where a vocal motor scheme is based on glottal articulation (e.g., [h], [ʔm̥]) however, the possibilities for exploration are more limited.

How do these playful vocal explorations relate to the development of early meaningful language? Here we invoke the Wernerian notion of "shift in function" (Werner & Kaplan, 1963). Vocal motor schemes first develop as a pleasurable activity in the course of exploring vocal capacities. This ability to form patterned but somewhat flexible articulatory plans can, however, shift function and become the basis for forming early words. This is demonstrated in the increase in palatal articulation or final consonants in words as opposed to non-words (Figure 1). When the child intends to represent a meaning by vocalization an automatized articulatory pattern provides a useful vehicle for simplifying the motor aspects of this complex cognitive task. Thus new vocal motor schemes suiting the vocal repertoire to specific aspects of language learning arise.

Whereas exploration with non-word vocal motor schemes is free and playful, as word schemes develop the same capacity for variation can be centered on particular word forms as targets. The simplicity of phonological shapes characterizing early words and the similarity of the phonetic tendencies exhibited in word use to those seen earlier in non-word vocalizations suggest that the earliest words may themselves be characterized as enriched vocal motor schemes invested with meaning.

Table 1. Use of vocal motor schemes by individual children.

S (N sessions)	Mean % use (N sessions of high use)						VMS score	Lexical score
	p/b	t/d	j	w	h	ʔm/ʔn		
Ai(8)	24(7)	12(5)	13(5)	06	13(5)	'07'	2.75	27
An(6)	00	04	01	01	50(4)	05	.66	0
Da(6)	06	24(3)	03	10	10	05	.5	0
JJ(8)	06	12(3)	07	08	14(5)	17(8)	2.0	5
Je(8)	05	07	05	08	33(7)	09	.88	1
Jo(7)	09	16(6)	06	09	17(4)	11(4)	2.0	2
Ka(7)	04	28(5)	04	03	13	07	1.14	2
La(6)	16	13(6)	04	12(3)	30(8)	04	2.83	11
Lu(8)	05	21(5)	07	04	14(4)	05	1.13	12
Pa(6)	11	23(8)	05	06	14(5)	06	2.13	8
mean	10	17	06	07	18	08		

VMS score = no. of mos. used as VMS, corrected for no. of sessions
Lexical score = total no. of strong nominal and relational words

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Figure 1. Palatal pattern

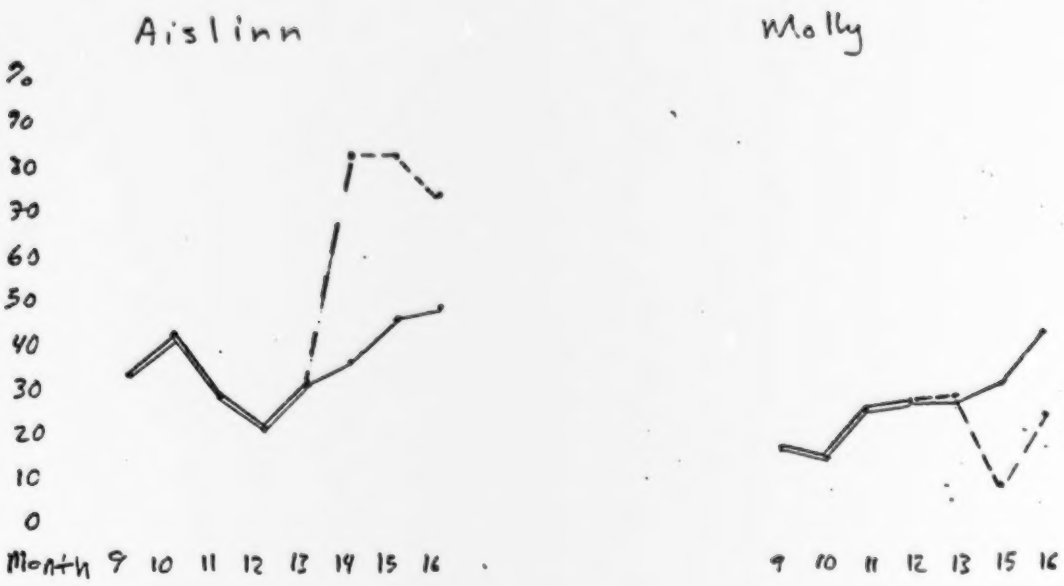
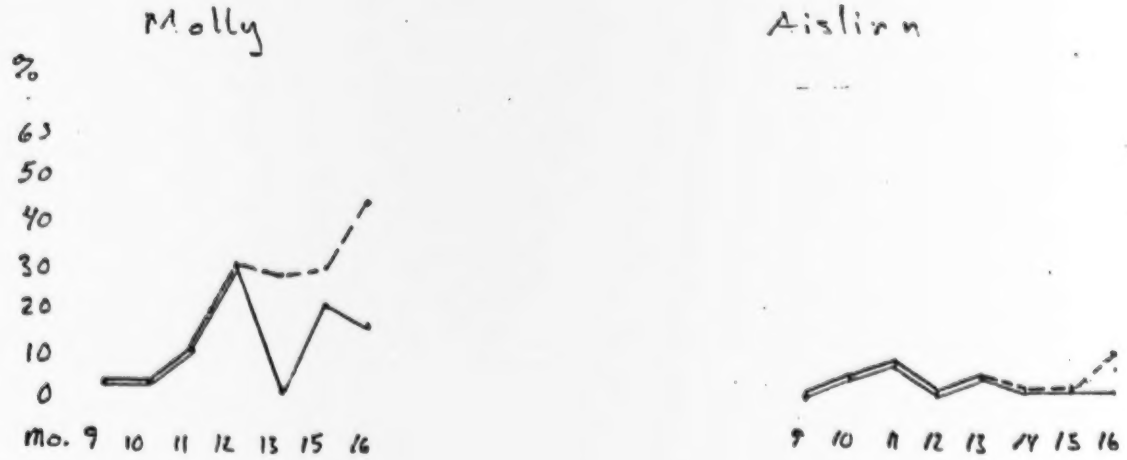


Figure 2. Final consonant use



Key: ═══ = non-word + word use
——— = non-word use
- - - - = word use